

NHDOT SPR2 PROGRAM
RESEARCH PROGRESS REPORT

Project # SPR 26962V		Report Period Year 2021 <input checked="" type="checkbox"/> Q1 (Jan-Mar) <input type="checkbox"/> Q2 (Apr-Jun) <input type="checkbox"/> Q3 (Jul-Sep) <input type="checkbox"/> Q4 (Oct-Dec)	
Project Title: The Development of a Predictive Tool for Bridge Condition with Respect to Recommended Investment Strategy			
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Project Start Date: 07/31/2019	Project End Date: 12/31/2021	Project schedule status: <input type="checkbox"/> On schedule <input type="checkbox"/> Ahead of schedule <input checked="" type="checkbox"/> Behind schedule	

Brief Project Description:

Reliable data-driven forecasting models allow for public agencies to plan for future needs and resource allocation. Conditions of bridge assets are managed through maintenance, preservation, rehabilitation and reconstruction. The New Hampshire Department of Transportation documents the appropriate timing of these treatments in Recommended Investment Strategies (RIS). According to NHDOT best practice and expert judgement adhering to a bridge's RIS extends useful service life. Quantification of the service life extension as well as tracking how well bridge investments have adhered to RIS remains a challenge. Bridge work is often documented in disparate formats through multiple bureaus and systems.

Element-level condition assessment data is collected and tracked in a standardized format for each bridge asset in a transportation network. Maintenance and repair records, however, are not and must be tabulated before correlation with other data. Correlating this tabulated data with conditions will support the development of deterioration models that function according to treatment actions, environmental condition and traffic usage. Condition forecasting using such deterioration models will provide insight into the long-term ramifications of investment strategies that leverage varying amount of maintenance, preservation, and rehabilitation

Objective of this project:

1. Data Collection and storage tool for bridge investment records
2. Recommended Investment Strategy adherence measure and effectiveness measure
3. Recommendation of appropriate deterioration models of NH bridge inventory
4. Proof-of-concepts deterioration forecast using a sample data set

Progress this Quarter (include meetings, installations, equipment purchases, significant progress, etc.):

Based on discussions with the project sponsor during 2020 Q3 and Q4, the UNH team paused most project activities so that the project scope could be reviewed and potentially revised, based on COVID-19 disruptions and current project progress.

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A revised scope, prepared based on discussions with the project sponsor and UNH team, is presented below:

1. Literature survey related to structural condition assessment of in-service bridges and use in deterioration modeling (currently being revised based on project sponsor feedback).
2. Design and deploy survey focused on RIS activities, including attention to both the activity and timing.
3. Post-process the survey results and conduct follow up interview(s) to develop a process for calculating RIS adherence factors.
4. Process currently available bridge condition and activity data and use the data summary to develop goals related for potential future projects related to RIS, data collection/management, and deterioration modeling.

The project team continued working remotely, due to COVID-19, during Q1 of 2021 and made progress on project tasks described below.

Literature reviews

Drafts of two literature reviews (and factor weighting/expert solicitation) were shared with the project sponsor. The literature review on bridge deterioration modeling is being revised based on feedback from the project sponsor, particularly to include clearer connections to the RIS adherence process. The literature review will include the relevance of existing bridge deterioration modeling research to RIS adherence and relevant information about data collection and best practices for potential future work on bridge deterioration modeling.

The project team shared a literature review on potential methods for developing and weighting RIS adherence factors. This review includes information that was used to inform the expert survey development, including quantitative methods for determining weighting factors with limited available data. There are several analysis weighting methods being investigated to best create a final ranking of the chosen RIS tasks. These methods include rank-order centroid, direct weighting, swing and ratio weighting and the analytic hierarchy process (AHP) weighting method. The recommended initial weighting method is the rank-order centroid method as it can be easily applied to the results of an expert survey and easily adapted and replicated for future needs. Once the RIS task weights are calculated from the rank-order centroid method, the AHP method is recommended to be utilized in order to create final weights for each RIS task from the expert survey. Given these recommendations, a literature review discussing each of the previously listed methods will be completed and resubmitted for final review and approval by the mid-April 2021.

Expert Survey and RIS Weighting Factors

Based on feedback from the project sponsor and TAG, the survey is being updated to address the importance of RIS activity timing, in addition to the relative importance of the activities themselves. Revisions to the survey plan include: collecting feedback on the revised survey from the project sponsor (feedback received in Q1) and TAG (feedback planned for Q2), sending the revised survey to a smaller list of NHDOT employees, primarily on the TAG, in AMPS, bridge design, and bridge maintenance, as well as a very short list of broader transportation community personnel.

The results of the first survey will be used to develop a second survey with detailed pairwise comparisons, and a group Zoom discussion will be scheduled after both rounds of the survey are completed.

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Participant Groups

The participant group was originally limited to a small group of DOT experts. As discussed in previous TAG meetings, there is value in including additional respondents for the online survey.

The project team would like feedback on the following draft list of survey recipients:

- All NHDOT employees involved in the original RIS development and recent refinement (we do not currently have these names);
- VTrans and Maine DOT heads of bridge maintenance and asset management.
- Head of municipal public works in Concord, Nashua, and Manchester; and
- Any individuals recommended by the TAG.

Once the results from the first online survey are post-processed, the project team is suggesting selecting a subset of the respondents for follow-up phone interviews and a group ZOOM discussion on key topics related to the RIS, its application and effectiveness.

After this first round, a second online survey will be developed for pairwise comparisons and a similar process for follow-up phone interview and ZOOM discussion will be conducted by the project team.

First Survey Questions and Format

The first survey has been updated to improve the balance of detail and difficulty comparing RIS activities and timing. The survey will be distributed after receiving feedback on the survey questions and participant list, likely in April 2021. The main survey questions are copied below. The five options for each question, regarding completion frequency, are the same throughout the survey.

The screenshot displays a survey interface with three questions, each with a dropdown menu for completion frequency. The first question, 'How frequently should the Clean and Seal; Clear Debris RIS Task be completed for optimal bridge condition:', has a dropdown menu open showing options: '6 months' (selected with a checkmark), '1 year', '2 years', '5 years', and '10 years'. The second question, 'How frequently should the Crack Seal Pavement RIS Task be completed for optimal bridge condition:', has a dropdown menu showing '6 months' selected. The third question, 'How frequently should the Pavement Inlay RIS Task be completed for optimal bridge condition:', also has a dropdown menu showing '6 months' selected.

How frequently should the Clean and Seal; Clear Debris RIS Task be completed for optimal bridge condition:

- ✓ 6 months
- 1 year
- 2 years
- 5 years
- 10 years

How frequently should the Crack Seal Pavement RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Pavement Inlay RIS Task be completed for optimal bridge condition:

6 months

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How frequently should the Patch Deck and Substructure RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Replace Membrane, Pavement, & Expansion Joints RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Rehab Bearings RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Touch up Paint RIS Task be completed for optimal bridge condition:

6 months

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How frequently should the Replace Deck, Membrane, Pavement, & Joints RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Replace Bearings RIS Task be completed for optimal bridge condition:

6 months

How frequently should the Patch Substructure RIS Task be completed for optimal bridge condition:

6 months

How frequently should the New Paint RIS Task be completed for optimal bridge condition:

6 months

If the bridge cannot be replaced on schedule, which is more important to bridge health and performance:

Clean and Seal; Clear Debris

1

Crack Seal Pavement

2

Pavement Inlay

3

Patch Deck and Substructure; Replace Membrane, Pavement, & Expansion Joints; Rehab Bearings; Touch up Paint (if applicable)

4

Replace Deck, Membrane, Pavement, & Joints; Replace Bearings; Patch Substructure, New Paint (if applicable)

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Please rank the following RIS task categories according to importance to complete on schedule to optimize bridge lifespan:

Clean and Seal; Clear Debris	1
Crack Seal Pavement	2
Pavement Inlay	3
Patch Deck and Substructure; Replace Membrane, Pavement, & Expansion Joints; Rehab Bearings; Touch up Paint (if applicable)	4
Replace Deck, Membrane, Pavement, & Joints; Replace Bearings; Patch Substructure, New Paint (if applicable)	5

Items needed from NHDOT

- Feedback on the proposed survey participant list; and
- Feedback on the proposed first survey draft.

Anticipated research next three (3) months:

In the next three months, the UNH team anticipates working on the following activities:

- The literature reviews will be revised into a final draft for inclusion in the project report.
- The survey will be revised, shared with NHDOT for final feedback, and sent to the final list of participants (as determined by project sponsor and TAG).
- The first survey results will be analyzed and used to develop the second survey.
- The second round of the survey (more directly addressing RIS factor weighting) will be distributed.
- The current data will be organized and analyzed to assess usefulness for RIS adherence measure.

Circumstances affecting project:

The COVID-19 pandemic has caused major disruptions to UNH and the broader community. Faculty and students continue to work remotely and are in a hybrid semester in Spring 2021, which includes a combination of remote work and restricted on-campus activity. Human subjects research is generally not allowed, particularly in cases where indoor face-to-face work is required, which is the case for this project. As reflected in the revised project scope, Task 3 from the project work plan cannot be completed because it requires visits to NHDOT offices and in-person coordination.

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Tasks (from Work Plan)	Planned % Complete	Actual % Complete
Task 1: Assessment of published data mining and analysis to select the appropriate scheme for NHDOT based on inventory and investment records. This assessment will include an evaluation of data availability and actions needed to improve availability, if appropriate.	100	75
Task 2: Development of a framework to measure adherence to RIS.	75	75
Task 3: Data mining and preparation of element level Bridge condition assessment data and maintenance records.	25	0
Task 4: Development of network level deterioration functions for bridge elements	25	25
Task 5: Proof of concept deterioration forecasts using sample adherences for New Hampshire bridges for girder-type bridges, including network wide and region/corridor-specific zones.	0	0
Task 6: Report Research Results and Deliver Final Products	0	0

Tasks (from updated Scope of Work)	Planned % Complete	Actual % Complete
Literature survey related to structural condition assessment of in-service bridges and use in deterioration modeling (currently being revised based on project sponsor feedback).	100	75
Design and deploy survey focused on RIS activities, including attention to both the activity and timing.	100	75
Post-process the survey results and conduct follow up interview(s) to develop a process for calculating RIS adherence factors.	25	0
Process currently available bridge condition and activity data and use the data summary to develop goals related for potential future projects related to RIS, data collection/management, and deterioration modeling.	25	25